

1. INTRODUCTION

During its first phase, the EIA ATV Multiport Receiver Subcommittee studied in detail the methods of standardizing ATV receiving system interfaces. Analog and digital delivery channels and their interoperability with NTSC and ATV receiving systems were investigated. It was concluded that a generic model for the ATV receiving system was important to define first. This model could serve as the basis for the definition of ATV receiver interoperability including functional and physical requirements in a multi-media environment. The "Reference Points" of the generic system model were identified to provide a consistent means to define the ATV receiving system physical interfaces. The group agreed that specific physical and electrical interface standards of an ATV receiver can be finalized once emission standards have been established. The group accomplished the classification of NTSC, ATV receivers/monitors and other video terminals, and the generation of a list of attributes for video, audio and data information channels.

The working group agreed on the following assumptions as boundary conditions of the ATV multiport studies:

- * All ATV receivers will be NTSC signal compatible.
- * The selected ATV signal for alternate media (e.g., cable, satellite, fiber optics, prerecorded media) could be different from the signal of the ATV terrestrial broadcast.
- * ATV signal over the telephone company fiber optic Broadband Integrated Services Digital Network (B-ISDN) will be in digital format in the longer term.
- * Maximum baseband video signal parameter commonality among the signals of alternate media is an important consideration for minimum cost solution and minimum signal degradation during format conversions in the emission and consumer environments.
- * Basic Video and Audio signal attributes of the ATV receiver will depend on the established ATV standard(s).
- * Full definition of the ATV receiver interface, control, conditional access, and data handling capabilities is necessary. The group assumed that conditional access may be provided by both external and internal hardware relative to the ATV receiver. The receiver should have a standard interface for the interconnection of the external conditional access hardware.
- * Standardization of any alternate media ATV emission signal does not imply that such standard need to be implemented in any ATV consumer product or system. If the receiver is to receive any of the ATV alternate signals however, and is claimed to be in compliance with the EIA ATV multiport television interface standard, then the receiver interface must have the characteristics required by the EIA ATV multiport television interface standard.
- * The EIA/ANSI 563 NTSC television interface standard can be a useful benchmark for the definition of ATV receiver multiport interface requirements.

2. ATV SYSTEM ARCHITECTURE

Figure 2.1 identifies building blocks of the ATV system and their functional interfaces. According to this diagram, the ATV system can be subdivided in the following modules: program production and TV studio, emission environment including feeder and distribution systems, and consumer equipment. These modules are interconnected via the following Reference Points:

- * Ultimate Single Worldwide HDTV Production Signal: HDP-W (Reference Point "A")
- * North American HDTV Production Signal: HDP-NA (Reference Point "B")
- * North American HDTV Emission Signal: HDE-NA (Reference Point "C")
- * ATV Feeder Signals (Reference Point "D")
- * ATV Distribution Signals (Reference Point "E")
- * ATV Receiver Multiports (Ports "E.1", "E.2" "E.n"):

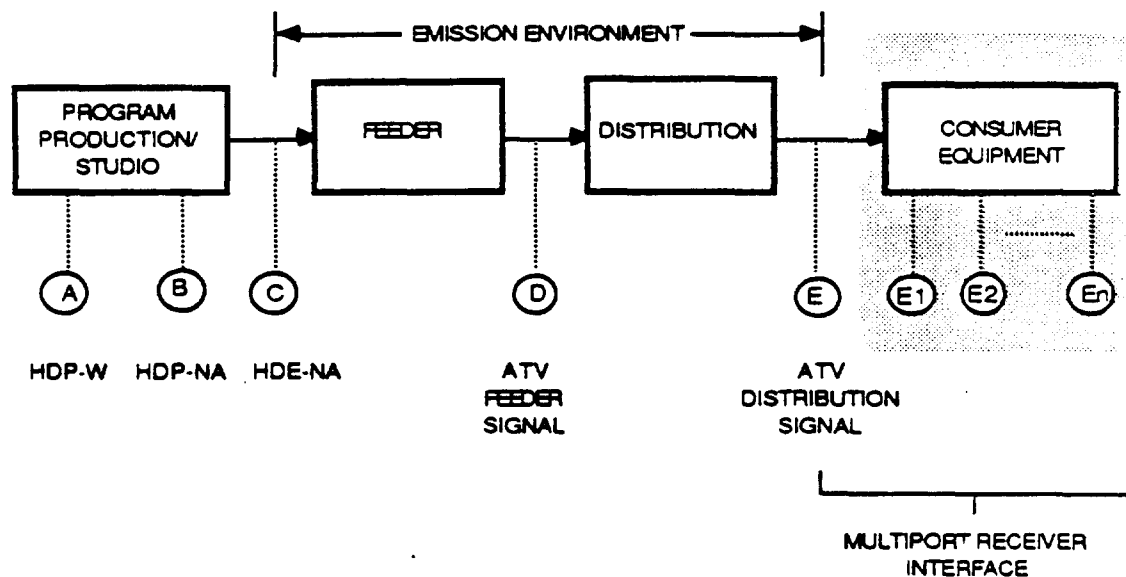


Figure 2.1: Generic ATV System Block Diagram

The primary focus of the ATV Multiport Receiver Subcommittee is to study the ATV consumer equipment and its E1, E2....En interfaces.

3. ATV MULTIPOINT RECEIVING SYSTEM ARCHITECTURE

Today's NTSC consumer terminals provide satisfactory interconnection by the use of the RF interface. However, TV signal interoperability at the RF level is not without signal degradation. In particular, in the high quality environment of ATV services and devices, the need exists for degradation-free interconnection.

Interface for conditional access provisioning can be satisfied by the EIA/ANSI-563 multiport NTSC receiver standard. This multiport standard also permits the interconnection of devices at the baseband video and sound signal levels. This standard was introduced in early 1989.

The EIA and its member organizations promoted the idea of extending the EIA/ANSI-563 multiport concept to ATV consumer devices and applications such that interconnection can take place without video and sound services degradation.

An ATV multiport receiver (MR) is shown in Figure 3.1. The input and output interfaces of the ATV receiver would allow maximum user flexibility for the interconnection. However, the baseband video parameters would be common for all applications resulting in a single set of display parameters. This solution provides a cost-effective approach to many ATV consumer applications. Study of the MR architecture and interface requirements for both analog and digital emission environments is well under way within the EIA.

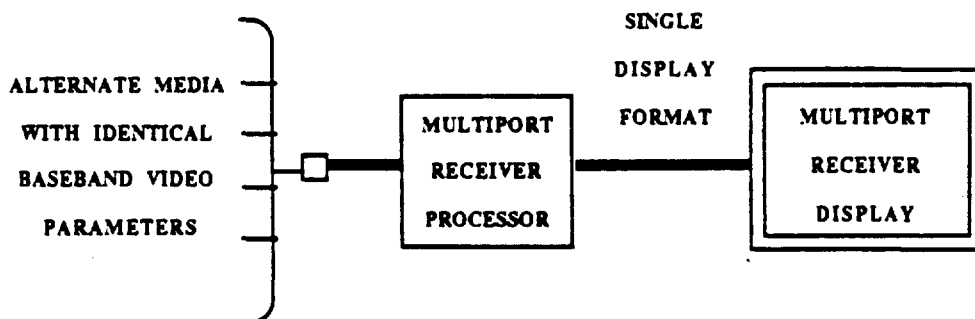


Figure 3.1: ATV Multiport Receiving System

In the ATV world, the multiport interface will provide the solution for high quality interoperability of consumer television receiving devices. The subcommittee outlined the following desirable ATV multiport receiver interoperability characteristics:

- * Multiple tuner/decoding functions to receive signals from alternate ATV media.
- * User equipment interconnection (analog and digital) at multiple interface points to reach maximum flexibility and maximum service quality.
- * The ATV receiver may either be equipped with decryption hardware to decode the service signals in an intelligible manner or be able to interconnect with an external signal decryption device for this purpose.

- * Implementation of user-friendly local control features is up to the consumer equipment manufacturer (e.g., remote controller). However, end-to-end control functions and emission network-to-consumer equipment control signals should be standardized.

To implement the interoperability characteristics listed above, an ATV consumer receiver, monitor or receiver/monitor should be equipped with a multiport interface as shown in Figure 3.2.

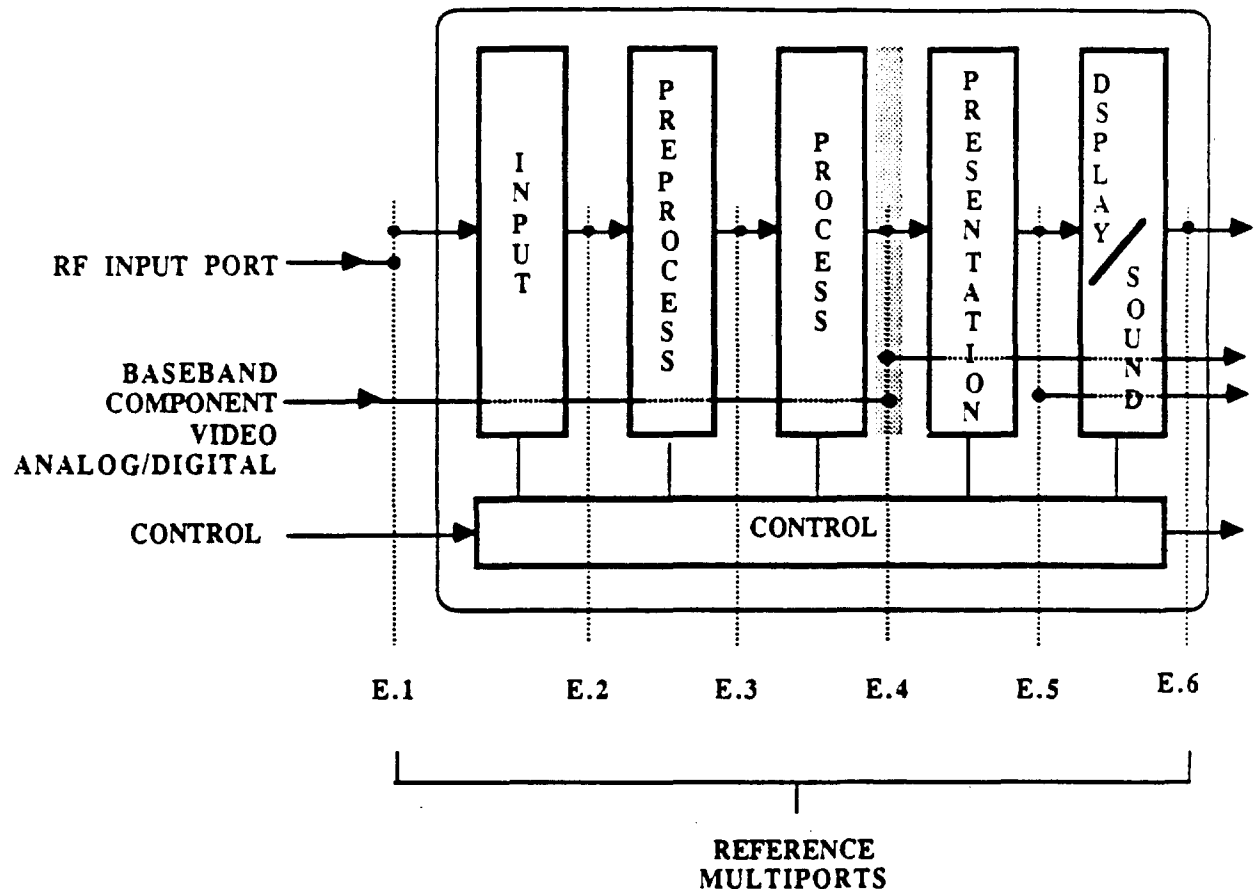


Figure 3.2: ATV Receiving System Architecture with a Multiport Interface

The definition of E.1 through E.6 Reference Ports are as follows.

- E.1: Input Port -- Reference Port for all signals entering the ATV receiving system
- E.6: Output Port -- Reference Port for all signals exiting the ATV receiving system
- E.2-E.5: Internal functional ports which may be exposed as standard external physical ports -- Reference Ports E.1 or E.6
- Note: Reference Port E.4 is defined as the baseband component video and baseband sound information port. The signal presented here is descrambled and ready to interface directly with another ATV receiving system at its equivalent E.4 port.

4. HIERARCHICAL ATV MULTIPOST RECEIVER INTERFACES

Figure 4.1.A through 4.1.C illustrates the possible configurations of the NTSC/ATV multipost receiving system interface according to the following classes of ATV consumer equipment.

-
1. Analog Minimum Service NTSC/ATV Receiver/Monitor (Figure 4.1.A)
 - * NTSC/ATV RF input port
 - * NTSC/ATV video and audio ports
 - * Optional other standard ports
 2. Analog Extended Service NTSC/ATV Receiver/Monitor (Figure 4.1.B)
 - * NTSC/ATV RF input port
 - * NTSC/ATV video and audio ports
 - * Conditional access port
 - * Optional other standard ports
 3. Digital Extended Service NTSC/ATV Receiver/Monitor (Figure 4.1.C)
 - * NTSC/ATV RF input port (analog)
 - * NTSC/ATV video and audio ports (analog)
 - * Digital ports
 - * Optional other standard ports (analog or digital)
 - * Optional conditional access port
-

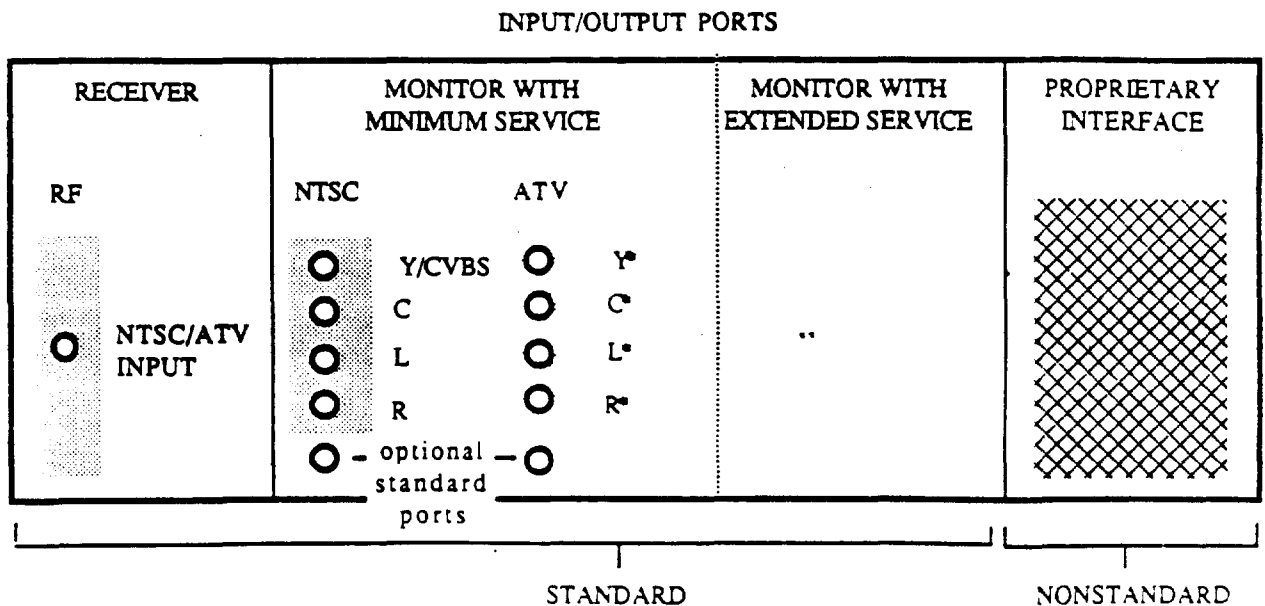


Figure 4.1.A: Minimum Service NTSC/ATV Receiver/Monitor

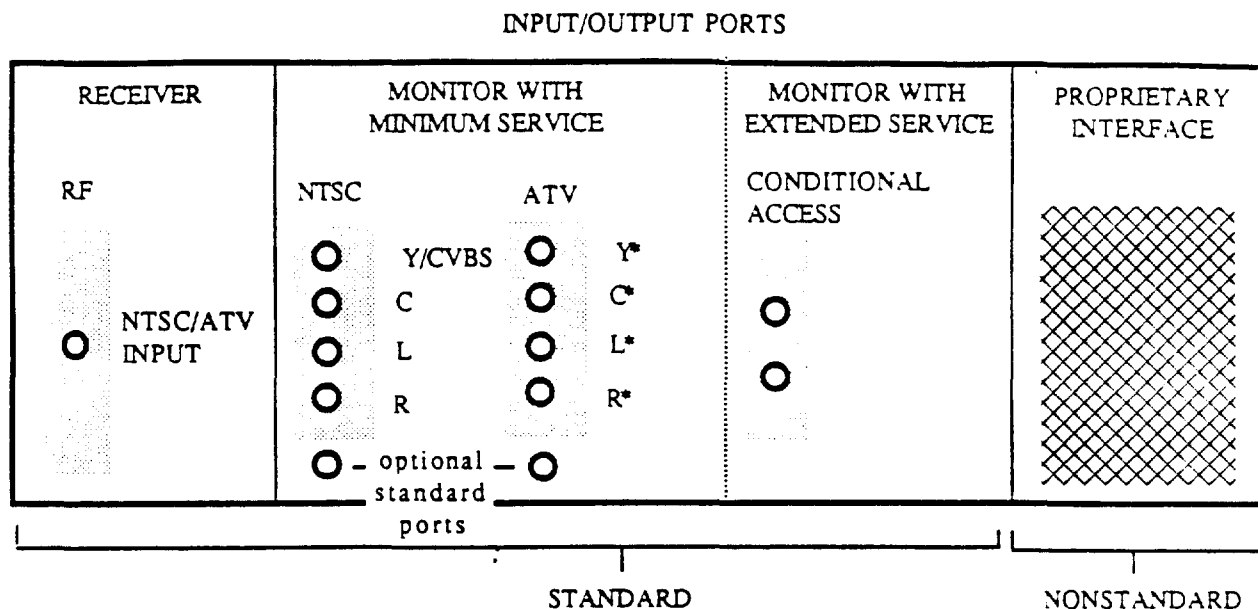


Figure 4.1.B: Extended Service NTSC/ATV Receiver/Monitor

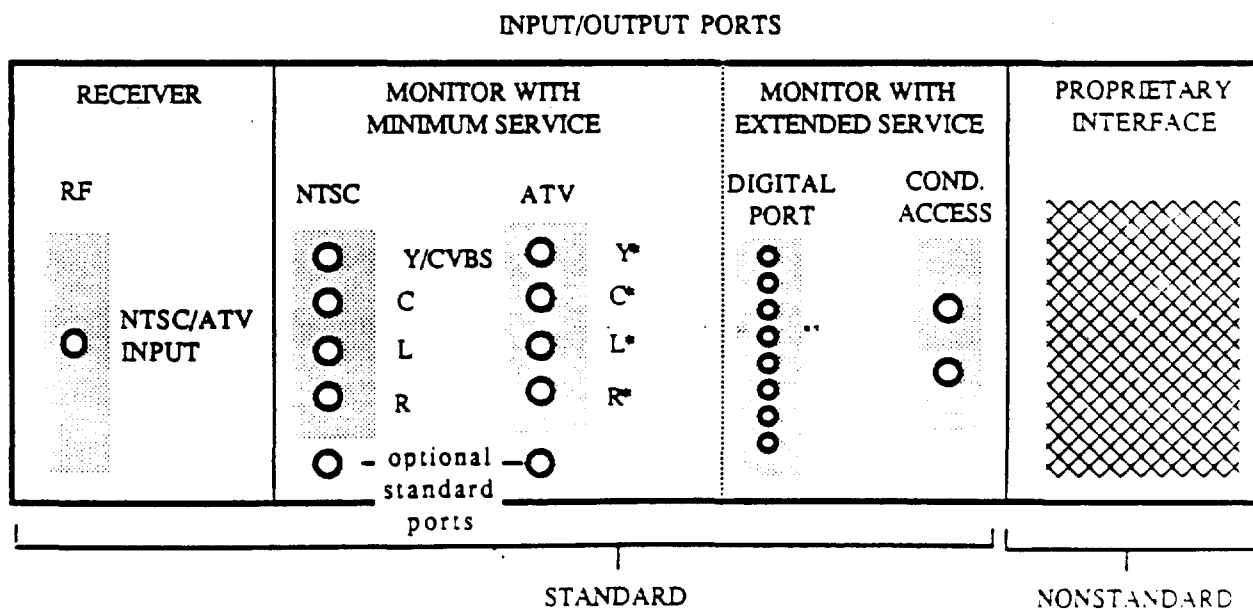


Figure 4.1.C: Digital Extended Service NTSC/ATV Receiver/Monitor

As illustrated by the diagrams, the multiport receiver will have the following physical interfaces:

* Minimum Service NTSC/ATV Receiver/Monitor

- Standard NTSC/ATV - RF interface
- Standard Interface - Baseband NTSC composite (CVBS) or Y component for S-VHS compatibility
 - Baseband NTSC C component for S-VHS compatibility
 - Baseband ATV Y component
 - Baseband ATV C component
 - NTSC Audio LEFT and RIGHT
 - ATV Audio LEFT and RIGHT

* Extended Service NTSC/ATV Receiver/Monitor:

- As in Minimum Service NTSC/ATV Receiver/Monitor plus
- Standard Interface - Conditional Access Interface

* Digital Extended Service NTSC/ATV Receiver/Monitor

- As in Minimum Service NTSC/ATV Receiver/Monitor plus
- Standard Interface - Digital Port
 - Optional Conditional Access Interface

* Nonstandard Ports: - Any (manufacturer's choice)

5. DIGITAL ATV RECEIVING SYSTEM EVOLUTION

In the "broadband digital world," the opportunity exists that TV sets may evolve to intelligent, multi-media, multi-service digital terminals. Despite this trend, there will always be the mass demand for application-specific single purpose consumer devices. It is highly unlikely that all TV receivers of the future will be built like a workstation, and similarly, a desk-top workstation will not be built like a "living room entertainment device". What is essential to recognize, however, is that the building blocks of both systems such as displays and VLSI will have much commonality and that these components will find application in multiple terminals.

Both home and office applications of CDV, CD-ROM, CDI, DAT and D-VCR technologies should be anticipated because of their expected attractive features and costs. Similarly, semiconductor techniques designed for digital ATV receiver signal processing and storage will find their way into office/business products. The cross-impact of consumer ATV receiving systems and office terminals will be considerable.

In some cases, video will be transmitted to consumer premises simultaneously with other information services (e.g., Broadband-Integrated Services Digital Network). In the B-ISDN environment, the segregation of the functional and physical elements of the in-home communication and video electronics, including the Network Termination (NT) module, the Terminal Adaptor (TA) and user terminals, requires joint attention by consumer TV equipment manufacturers, telcos and telecommunication equipment suppliers. The EIA ATV Multiport Subcommittee has taken the initiative for such joint studies. A Workshop on Digital ATV Services and Systems was organized in November 1989 and the subcommittee has formed a Study Group on Digital ATV Multiport Receiving Systems.

6. OBJECTIVES AND PROPOSED MILESTONES FOR THE NEXT STUDY PHASE

The working group identified the study objectives for its next phase as follows:

- * Definition of analog multiport ATV receiver interface
- * Study of digital broadband/video access techniques
- * Definition of digital ATV multiport interface in the B-ISDN and other digital network environments
- * Analysis of digital ATV-VCR coding and interface requirements
- * ATV receiving system control requirements
- * ATV receiving system baseband parameter standard

The proposed main milestones in the 1990-94 study period are the following:

- | | | |
|---|--------------|-----------|
| * Generic ATV receiver model (Phase I) | Report | Complete |
| * Analog ATV multiport definition | Report | 2-3Q 1990 |
| * Digital ATV multiport interface requirements | | 4Q 1990 |
| * Digital ATV multiport definition | Report | 1H 1991 |
| * Control and data requirements | | 1H 1991 |
| * ATV receiver parameter standard
(after ATV emission system standards) | | 2H 1992 |
| * Analog ATV Multiport Standards Document
(after ATV emission system standards) | Final Report | 1H 1993 |
| * Digital ATV Multiport Standards Document
(after ATV emission system standards) | Final Report | 1H 1994 |

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U.S. House of Representatives

Committee on Energy and Commerce

SUBCOMMITTEE ON TELECOMMUNICATIONS AND FINANCE

Washington, DC 20515

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PA/WP4-0067

SUBCOMMITTEE ON TELECOMMUNICATIONS AND FINANCE DEMONSTRATION OF NON-ENTERTAINMENT APPLICATIONS OF HIGH DEFINITION AND HIGH RESOLUTION SYSTEMS JUNE 18-19 1990

Telecommunications industries are being swept into a maelstrom of new and developing technologies; colliding, combining, and converging, into unforeseen and exciting permutations. At the center of the whirlwind stands high definition television (HDTV), a convergence of digital-based computer technology with television to produce new visual displays that offer high resolution, wide screens, and digital-quality sound that almost certainly will transform the way entertainment programs will be delivered and displayed.

The most crucial, and perhaps the most exciting, applications of HDTV, however, go well beyond entertainment alone. Personal computers, semiconductors, fiber-optic systems, and satellite delivery technologies all touch upon or are touched by HDTV's promise. The fields of medicine, manufacturing, aerospace, publishing, computing, and defense all stand to benefit from developments in HDTV and display technology.

HDTV is closely linked to other key industries and technologies whose collective future will help shape much of our economy and society into the next century. HDTV challenges us to deal with crucial public policy issues in manufacturing, strategic economic planning, domestic and international standardization, relationships between government and business, and accelerated change in the telecommunications sector.

The House Subcommittee on Telecommunications and Finance is sponsoring this exhibition of HDTV applications so that attendees can acquire the perspective to view this whirlwind of converging technology not with consternation, but with anticipation of the many benefits high resolution display systems promise.

Bell Communications Research (Bellcore)

The Bellcore demonstration focuses on how Broadband Integrated Services Digital Networks (BISDNs) can provide a unique vehicle for delivering advanced television (ATV) services to the nation. The demonstration highlights the ability of optical fiber networks, with their natural high bandwidth capabilities, to deliver ATV with no compromise in quality. When combined with switching and customer control, these networks can provide a powerful set of visual communications capabilities for the

nation's hospitals and schools.

Bellcore's demonstration shows a coronary bypass operation performed by Dr. Denton Cooley and taped previously in Houston, which is being transmitted through twenty-five miles of fiber optic cable installed in the Cannon House Office Building. In Bellcore's lifelike scenario, medical students at a remote location can observe the procedure as if they were in the operating room with the surgeon.

Compression Labs, Inc.

Compression Labs, Inc. demonstrates an HDTV "codec" which digitizes and compresses HDTV video so that it can be transmitted over low-cost, ubiquitous T-1 telephone lines. Compression Labs, Inc. designed this codec for internal use by a Japanese company in a high-resolution videoconferencing application. The client requires the high resolution of HDTV for accurate representation of graphics and Kanji characters. In this application accurate video motion portrayal is secondary. Accordingly, the codec compression technique maintains HDTV spatial resolution but sacrifices motion rendition by displaying video at only five frames per second instead of the normal thirty frames per second.

Corabi International Telemetry/Ikegami Electronics USA

Corabi International Telemetry, a Maryland corporation with offices in Alexandria, Virginia, exhibits a form of high definition television called PDQ-TV (Professional Diagnostic Quality Television) which is designed specifically for medical applications. In its demonstration, Corabi compares the PDQ-TV HDTV video image to an image displayed on a standard NTSC broadcast monitor to enable the viewer to make direct comparisons between the technologies. PDQ-TV is designed to meet the needs of the medical community by providing a real time, full motion, high resolution, flicker free color image. Corabi has defined the requirements for this medical high definition video system through human performance trials conducted at Rush-Presbyterian St. Luke's Medical Center in Chicago, Illinois.

Corabi, in conjunction with Ikegami Electronics USA, Inc., defined and built the HDTV video system which is the backbone of the Corabi DX-1000 telepathology system. The Corabi DX1000 system utilizes specialized medical HDTV technology, robotics and computers to transmit diagnostic quality images from one hospital to another. These high definition, full motion images can be transmitted between hospitals located in the same town or hundreds of miles away. The Corabi DX1000 telepathy system is media independent since it can operate on broadband fiber optic cable, microwave, or satellite to achieve transmission of these medical HDTV images.

Ford Motor Company/Shima Seiki

Ford Motor Company demonstrates the Shima Seiki HDTV Paint System it has been using in its design studios for the past 12 months to develop design sketches and presentations. The wide aspect ratio and high-resolution that HDTV offers, coupled with the ability to interface to high definition video cameras and VTR's, provide the designer with a powerful tool capable of creating the realistic images necessary to achieve design direction.

NHK Japan Broadcasting Corporation

The Metropolitan Museum of Art, Polaris Entertainment, Inc. and NHK Japan Broadcasting Corporation demonstrate HDTV applications for an art museum. The exhibit features two types of applications: "Frederic Remington: The Truth of Other Days", an art program produced by the Metropolitan Museum of Art; and the HDTV graphic system currently in service at the Museum of Fine Arts, Gifu, Japan. The graphic system is interactive and visitors can select art programs they want to see from the menu. Equipment being used for the event includes one 1/2" VCR, HDTV graphics, and 50" rear projectors.

Ovonic Imaging Systems, Inc.

Ovonic Imaging Systems, Inc. demonstrates two high definition applications of its "giant microelectronics-on-glass" technologies: Color Flat Panel Displays and Image Scanners/Digitizers.

Panasonic ATVL

Panasonic ATVL displays an optical disc filing system for still images and computer graphics. By simple interactive means, digital images and sounds stored in the HDTV optical disc filing system can be located and reproduced on HDTV monitors in lecture halls or conference rooms. Art museums already are using this kind of system, and Panasonic ATVL is developing applications for libraries and other locations.

Scientific-Atlanta

Scientific-Atlanta displays a live satellite feed from an existing High Definition Television Network as an example of a current commercial application. Scientific-Atlanta has sold three HDTV networks (two in Canada and one in the United States) and an additional commercial application with the MAST Corporation between Massachusetts and Hong Kong for strategic planning purposes. In a venture with Comsat Video Enterprises,

Scientific-Atlanta has established an HDTV satellite network throughout the United States. This network will be used to transmit a Dionne Warwick benefit concert to 14 cities on June 11. Scientific-Atlanta is the world leader in HDTV satellite transmission and is the only company with a commercially available delivery system for fiber, cable and satellite. Scientific-Atlanta is in the process of developing new applications and markets for its system.

Symbolics Graphics

Symbolics demonstrates the first commercially available HDTV videographics workstation. This is the first product to merge computer graphics and high definition video processing, thereby eliminating the technological barriers that previously existed between these two worlds. This product, which is based on Symbolics' new FrameThrower technology, supports the entire range of video formats including all popular broadcast, computer, and proposed HDTV formats. It also supports real time frame-grabbing and universal genlock. Applications include mapping, command and control, simulation, graphics arts, modeling, CAD/CAM, animation, and scientific visualization.

Zenith Electronics Corporation

Zenith Electronics Corporation, the only independent U.S. color television and picture tube manufacturer, exhibits its advanced high-definition display technologies. On 15-inch "flat tension mask" (FTM) displays, Zenith displays high-definition workstation graphics, as well as non-entertainment applications of the company's progressive-scan "Spectrum Compatible" HDTV transmission system. Zenith also demonstrates a prototype 20-inch FTM high-resolution color display and discusses its strategy for low-cost, high performance, large screen FTM displays.

HDTV 45 Mbps Video Coder/Decoder



Advance Information

The Compression Labs HDTV 45 Mbps Video Coder/Decoder is the first high definition television product for transmitting broadcast quality video at bit rates from 45 to 140 Mbps. These low bit rates permit economical digital transmission of high definition video over the ever-expanding network of DS-3 lines, as well as 27 and 54 MHz satellite channels. Future support of B-ISDN will be available. Proprietary CLI compression technology enables reduction of the enormous amount of raw data in HDTV to a rate compatible with economical transmission media.

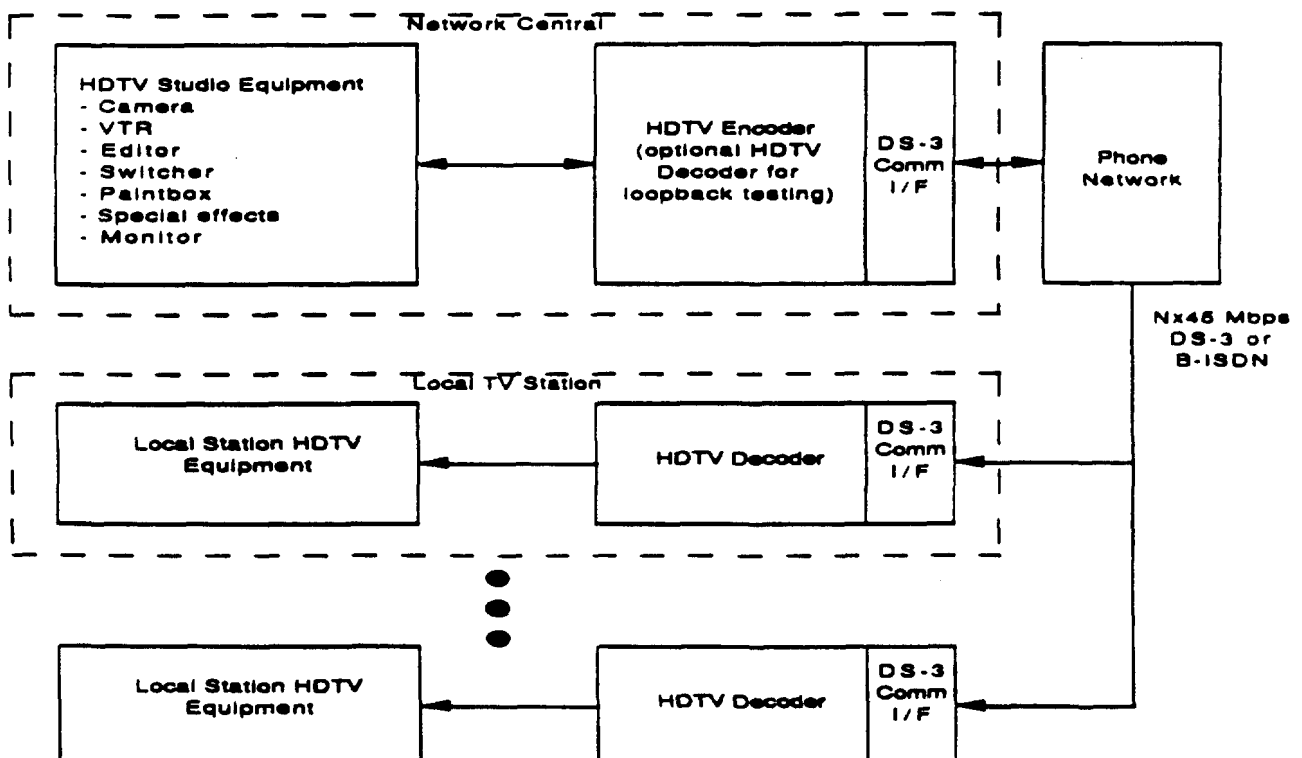
HDTV Coder/Decoder Applications

- Broadcast video distribution
- Videoconferencing
- Education & training
- Motion picture distribution
- Television advertising distribution
- Medical remote diagnosis
- Military & intelligence

HDTV Coder/Decoder Features

- Digital video compression permits HDTV transmission over terrestrial phone lines
- Compression lowers transmission costs
- Lowered bit rates & digital format allow transmission channel selection flexibility
- Broadcast quality video
- Robust, high-quality, noise-free transmission over digital channels
- Four channels of CD-quality audio
- Adheres to SMPTE 240M, with flexibility to migrate to evolutions of this and to meet other production standards that may arise in Europe and Japan
- Flexible, modular architecture allows serving a variety of bit rates and applications, and provides customers an upgrade path
- Digital encryption for security
- Send-only & receive-only configurations available for point-to-multipoint applications
- Built-in diagnostics
- Coder & decoder can be slaved to form codec

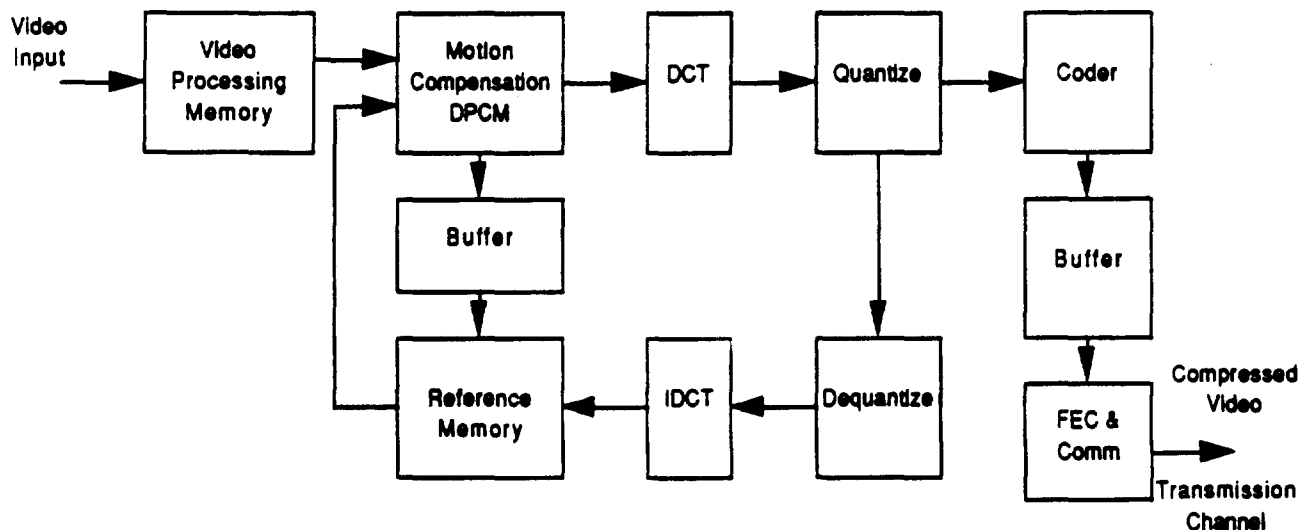
HDTV Coder/Decoder Point-to-Multipoint Distribution Application



Specifications

Video Interface		Transmission	
	SMPTE 240/M, 1125/30 Y=30 MHz, P _R , P _B =15 MHz Tri-level Sync	Digital Channel	DS-3 & multiples + B-IDSN (45, 90, 140 Mbps)
Interlace	2:1	Forward Error Correction	Sufficient for fiber optic error rate objectives
Vertical Resolution	1035	Encryption (option)	DES
Horizontal Resolution	1920		
Aspect Ratio	16:9		
Signal-to-Noise Ratio	>50 dB	Environmental	
Compression	DCT with motion compensation using proprietary CLI technology	Operating Temperature	10° to 40° C
		Humidity	15% to 95%
		Heat Dissipation	BTUs/hour typical
Audio Interface		Mechanical	
	Digital audio 800 Kbps/chan uncompressed	19" rack-mountable	
Number of Channels	4	Separate coder & decoder	
Compression	4:1, <200 Kbps/chan		
User Interface		Power Requirements	
Front Panel Control & Serial Interface		USA	90-132 VAC, 47-63 Hz
<ul style="list-style-type: none"> - Select bit rate (channel select) - Select audio channel configuration - Select Maintenance 		International	180-264 VAC, 47-63 Hz
		Optional Telco Power	-48 to -56 volts

HDTV 45 Mbps Video Coder/Decoder Block Diagram



TAE

FOURTH INTERIM REPORT OF THE
WORKING PARTY 5 ON ECONOMIC FACTORS AND
MARKET PENETRATION

of the

PLANNING SUBCOMMITTEE

of the

ADVISORY COMMITTEE ON ADVANCED TELEVISION SERVICE

March 4, 1991

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION AND BACKGROUND
2. WORK STATEMENT
3. THE SECOND SET OF MARKET PROJECTIONS
 - 3.1 Price elasticity
 - 3.2 Historical models
 - 3.3 Penetration Scenarios: the second set of market projections
4. NEW CONSIDERATIONS AND THEIR IMPLICATIONS FOR MARKET PROJECTIONS
 - 4.1 Digital technology
 - 4.2 Transition scenarios
 - 4.3 Programming
 - 4.4 Conclusions
5. FURTHER WORK
6. DOCUMENTS
7. MEETINGS

EXECUTIVE SUMMARY

During the fourth period of work, WP-5 continued studies leading to a revised projection of the rate of penetration of ATV receivers in the US market. This projection was based on new assumptions on the price elasticity of an ATV receiver; the possibility that Europe and Japan may begin large-scale production of ATV receivers before the US; and on an initially limited availability of ATV programming. A range of scenarios was considered, driven by a range of underlying assumptions.

Subsequent to the development of this second penetration scenario, and in concert with the work of SS WP-3, further considerations were taken into account. These included the economic impact of new technology applied to ATV signal transmission, and the feasibility of providing at the inauguration of ATV service a full schedule of broadcast service.

These considerations, taken together, suggested that the upper bound of the the second penetration scenarios may indeed be realized, or even possibly exceeded. It is therefore the view of the Chairman of WP5, and certain other members, that, after an initial one percent penetration of the market has been achieved perhaps by the alternative ATV distribution media, a ten percent market penetration could be achieved in five years and 40 percent in ten years. However, this view has not been reviewed by the full Working Party subsequent to its consideration of the various recent working documents on new technology and expected availability of programming.

1. INTRODUCTION AND BACKGROUND

Following the development of an initial projection of potential penetration of ATV receivers in the market place by the Working Party on Economic Factors and Market Penetration (WP5) it became clear at the beginning of the work period just completed that some of the underlying assumptions were very conservative, and should be reviewed in the light of new technology being developed for the terrestrial transmission of ATV signals. The initial penetration scenario was considered highly conservative by some (but not all) members of WP5 and informed outside observers. It was more pessimistic than most (but not all) projections published previously. During the second and third Advisory Committee work periods, additional information on technology and several economic issues, including price elasticities of demand, became available.

During the fourth work period, therefore, WP5 reviewed the new information and revisited the key assumptions underlying its projections of market penetrations, and a second set of penetration scenarios was developed, working in collaboration with SS WP-3.

Subsequently, additional perspectives were gained, which suggested that even the second set of penetration scenarios may still be somewhat conservative.

This report briefly revisits the second set of scenarios for market penetration, and discusses the possible impact of the most recent perspectives on the assumptions used to develop the second set of penetration scenarios. It also presents a preliminary discussion of what impact these new considerations may have on the overall projected level of market penetration. It should be noted, however, that while this discussion reflects the views of the Chairman of WP5 and certain other WP5 members, it has not yet been reviewed or approved by the Working Party as a whole.

2. WORK STATEMENT FOR THE FOURTH PERIOD

WP-5 was required to perform the following work:

- Estimate costs to convert present NTSC stations to ATV simulcast operation, basing equipment costs on a competitive market place

- Develop a family of market penetration projections in conjunction with SS WP-3

- Investigate the implications of ATV policies for industrial development and international trade.

During the work period, most of the effort has been directed to the first two requirements, and the results obtained are presented below.

3. THE SECOND SET OF MARKET PROJECTIONS

The second set of penetration scenarios were developed based on the considerations of new information or estimates in the following five areas:

- Price elasticity

- Projected ATV program availability

- Estimated rates of cost reduction based on consideration of potential by global economies of scale and manufacturing experience

- A review of the validity of the historical models used as a guide to market penetration

- New assessments of the likely impact of new and developing technology on the prior assumptions

3.1 Price Elasticity

Price elasticity was studied by Ken Dunmore of Economists Incorporated. In his report (Document NO. PS WP-5-0041), it was concluded that the demand for television receivers is very price elastic, and that long run price elasticities of demand for color TV sets average -1.3. Large screen sets, however, were found to have a price elasticity of about -0.7 in one study.

The demand for TV receivers becomes more price-elastic over time. For large screen sets of introduction, the elasticity is near zero.

In a subsequent study by Booz, Allen and Hamilton, it was decided to use a price elasticity of -1.75, for development of the second penetration scenario.

3.2 Historical Models

WP5, with written inputs from several participating individuals and organizations (see section 6) reviewed a wide range of possibilities for historical analogies with market-penetration experience with other innovations in consumer electronics and/or entertainment.

Superficially, the VCR would appear to be a useful historical model for the development of ATV penetration rates, but certain limitations are evident. Firstly, the VCR, in its initial consumer application of time-shifting broadcast television programs, did not provide a service of new or different programs, and it did not enhance the technical quality of the display. Rather, it simply addressed the needs of the consumer for a time shifting mechanism for his TV viewing convenience.

For the first three years after the introduction of the VCR, there was a lack of non-broadcast programming available for home viewing on cassettes, either for sale or for rental. Only when a wide range of programming became available for rental at low cost, did VCR penetration of the market increase rapidly. This fact alone constrains the use of the early adoption rate of the VCR as a guide to the likely penetration rate of ATV receivers.

The use of color TV as a historical model has the merit of an intuitive similarity to ATV adoption, and a high introductory consumer cost comparable -- in constant dollars -- to possible ATV receiver prices, but suffers from one serious limitation.

As shown graphically in Figure 1, as the consumer cost of a color TV set fell dramatically in the first years of introduction, market penetration made virtually no gains. Only in 1966, when all three networks first provided a full schedule of primetime programming in color, did penetration begin to advance rapidly.

COLOR TV SET PENETRATION COMPARED WITH COST OF A COLOR TV SET

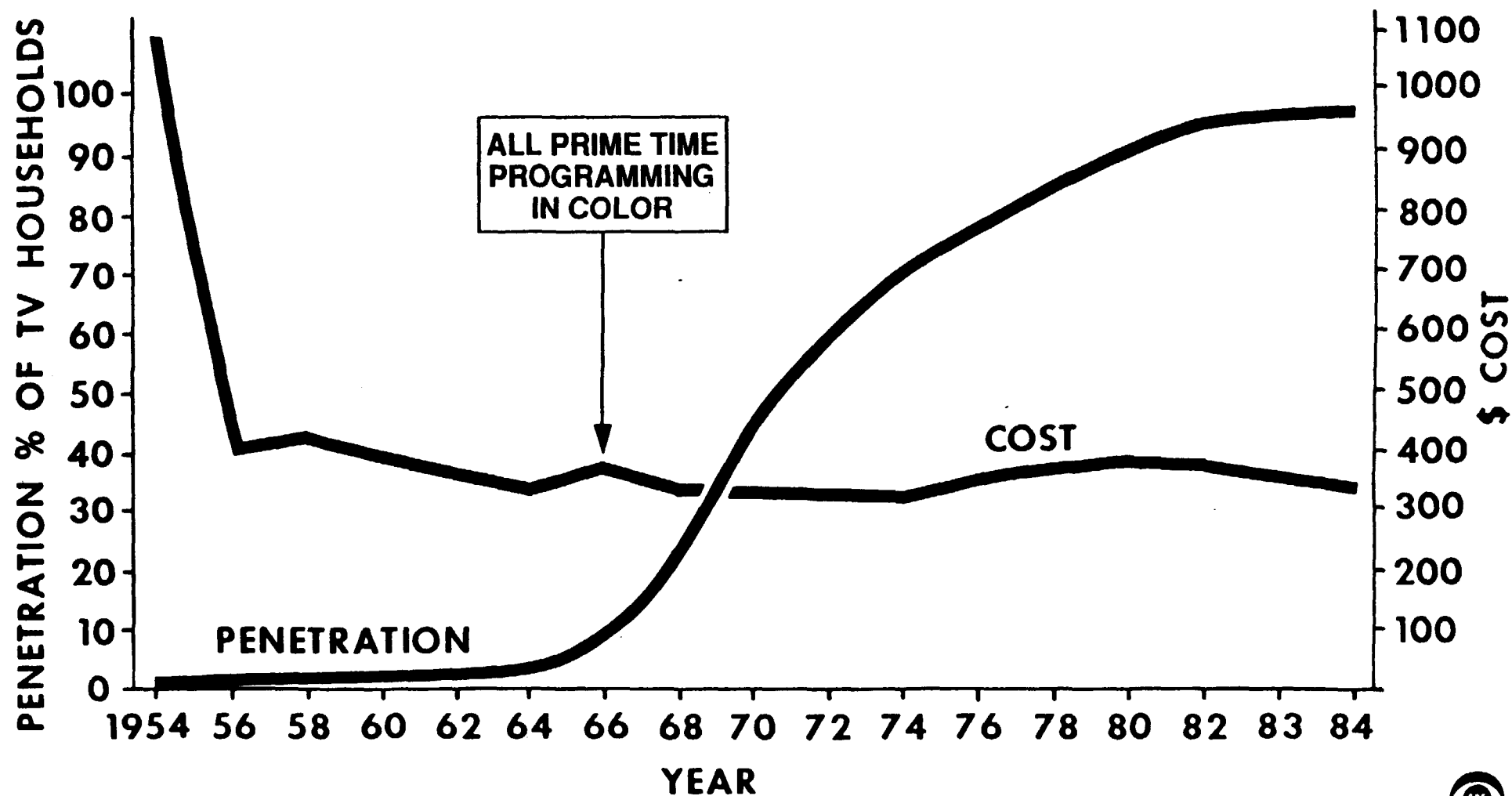


FIGURE 1



If in fact ATV service can start with a full schedule of ATV programming on the simulcast channel (see discussion in section 4 below), it is arguable that the early program-hungry years of color TV should be discounted in using color TV as a historical model.

However, at the time of color's rapid penetration of the market, the consumer price of a color set was much less than present expectations of the price of an ATV set at its market introduction.

Finally, it should be noted that no valid studies exist which compare the consumer's perceived value of a color TV set with that of an ATV receiver.

From these considerations, it may be concluded that if the color TV or VCR be used as a model for penetration, allowance must be made for the lack of available programming in the first years of introduction until a one percent penetration rate was achieved.

3.3 Penetration Scenarios: the Second Set of Market Penetrations

This scenario was developed largely by the staff of Booz, Allen and Hamilton, and subsequently adopted by WP5 as an acceptable broad indication of possible future market trends, rather than a firm forecast. Its development was influenced primarily by the following considerations:

- The new price elasticity estimates and new estimates of the ATV receiver costs at market introduction
- The possibility that Europe and Japan might begin large scale ATV receiver production alongside, or before, the United States. Booz, Allen's prior model of potential cost and price reductions for ATV receivers was based on consideration of the US market alone. This model was revised, using the working assumption that production in Europe and Japan would begin in 1993, and that US-based production would begin in 1996. If this occurs, it will result in somewhat lower ATV receiver costs when the US enters the market, through the earlier achievement of economies of scale and manufacturing design efficiencies and experience
- A judgement that the inherent attractiveness of ATV to the consumer will be greater than presumed in the prior estimates, based in part on considerations put forward by Larry Thorpe of SS WP-3 concerning opportunities for optimizing programming formats to make full use of the capabilities of ATV

The second penetration scenario, however, retained the following assumptions underlying the first scenario, namely:

- The ATV signal would be downward compatible with NTSC
- Three years after introduction, ATV would exist in 15 percent of TV stations, five of the largest cable TV programming networks, and in 15 percent of cable systems
- Consumer preference for ATV relative to NTSC would be less than that for color TV versus black and white TV
- The ATV receiver price in each year after introduction would be similar - in constant dollars - to the price of color TV in the same number of years after the introduction of color.

From these considerations and assumptions, three projections were developed, optimistic, pessimistic and mid-point projection. This last projection suggests that the ATV receiver penetration will be five percent five years after the introductory one percent has been achieved, and 30 percent 10 years after the one percent level of market penetration has been reached.

Following the issuing of these projections by WP5 a number of technical developments have occurred which may further impact the second penetration scenario, and these are now discussed.

4. NEW CONSIDERATIONS AND THEIR IMPLICATIONS FOR MARKET PROJECTIONS

4.1 Digital Technology

The most important technical development during the fourth work period in terms of its indirect implications for the prospect of early market penetration by ATV is that all but one of the proponent systems now propose to use an all-digital terrestrial transmission system. Inter alia, this will result in lower power and lower cost transmission equipment, and will enable TV stations to effect the transition to simulcast ATV service at a much lower cost than previously projected, as reported in the following section.

It is further expected that costs and prices for ATV receivers will be somewhat lower than the previous WP5 estimates if a digital transmission standard is selected by the FCC. This change would, however, have little or no impact on the cost of the consumer display, which remains the largest single cost component of the ATV receiver, at least for the period in which a CRT is the only practicable display device.